NEWCASTLE HARBOUR

SUBMISSION FOR RECOGNITION

AS A

NATIONAL ENGINEERING LANDMARK

NOMINATED BY: NEWCASTLE DIVISION COMMITTEE
THE INSTITUTION OF ENGINEERS, AUSTRALIA

The Institution of Engineers, Australia

Newcastle Division
The Bolton Building
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Newcastle NSW 2300
Phone (049) 26 4440

17th January 1989

The Institution of Engineers, Australia,
11 National Circuit,
BARTON A.C.T. 2600

Dear Sir,

This is to nominate the following work as a National Engineering Landmark.

Name of Work:	Newcastle Harbour
Location:	Newcastle, N.S.W.
Owner:	State of N.S.W. (Maritime Services Board)

1. Date of Construction - continuous activity from 1818 to 1983.

Major Stages

1818	First ocean breakwater commenced
1855-1861	Moriaty plan developed
1861-1874	Construction of Dyke and cityside river training walls
1861-1950	Extensions of training walls, building and extension of ocean breakwaters, land reclamation and wharf development limited rock breaking on bars.
1961-1983	Major rock breaking on bars from 8.4m to 11.6 then 15.2m (For details see Attachments B and E)

2. Key Engineering Personnel.

The key plan which made continued development possible was produced by Edward Orpen Moriaty C.E. born 1824; Engineer for Newcastle Harbour Works 1855-1858; Engineer-in-Chief, Harbours and Rivers Branch of P.W.D., 1858-1888.

Work was entirely under control of Public Works Department until 1958. It was then phased to complete control by P.W.D. IN 1971. (For list of engineers with major responsibility for Newcastle Harbour Works see Attachment E.)

3. Historical Engineering Significance.

3.1 The successful conversion of an almost unnavigable estuary to the largest modern deepwater port in Australia by continuous development over 125 years to a basic plan of 1860. This harbour is an excellent example of major engineering works of very long duration (Attachments B, H and I)

3.2 The river training proposal (of which the Dyke is a significant feature) for a wide estuary with moving tidal siltation was in 1854, a very advanced proposal by world standards and was successful (see Attachments F and G).

3.3 The Macquarie breakwater, commenced 1818, was the first ocean breakwater construction commenced in Australia and a major convict works.

4. Comparable or Similar Works.

The later development of Liverpool harbour in U.K. is a similar treatment of an estuarine problem. The Liverpool problem did not combine with the problems of hard rock bars with ocean exposure and of very extensive siltation which had to be contended with in Newcastle.

5. Features setting this above other Engineering Works.

The extensive harbour works of Melbourne and Brisbane involved more conventional problems.

1. The production by 1861 of a harbour development plan for an estuary with about 5m navigable depth in shifting channels which provided a base for continuous development to the present 15.2m depth.

2. The continued engineering to overcome obstacles to such development (eg. the breaking of hard rock bars with ocean exposure).

3. Coping with regular extensive siltation.

4. Continuous breakwater development from 1818 to 1950.

6 a. Development of Engineering.

Both in construction aspects (eg. breakwater construction, underwater rock breaking, estuary dredging) and in research (particularly siltation), Newcastle harbour works contributed extensively to development of harbour engineering in Australia.

6 b. National Development.

It was only the continued development of the Port of Newcastle to a standard acceptable to shipping of the time which made the development of the Newcastle coal field and later Newcastle steel works possible. Shipping of Newcastle Coal to Melbourne, Adelaide, Hobart, Perth etc. gave these cities up until well into this century energy supplies at much lower cost than could be obtained elsewhere.

Documentation is listed on Attachment A.

Proposed Wording on Informative Plaque - Attachment C.

We have discussed the nomination with the owner of the work and the main constructing authority who are in full support (Attachment J).

Signed: ______________________
Division Chairman

Dated: 17.1.89.

NEWCASTLE HARBOUR.

A. DOCUMENTATION

B. BRIEF HISTORICAL REVIEW

THE PORT OF NEWCASTLE - A NOTABLE ENGINEERING LANDMARK

The development of the Port of Newcastle from a shallow shoaled estuary with dangerous sea entrances to a modern deepwater port is the result of over 150 years of continuous engineering development to a consistent plan.

It is important that it should be recognised by the profession as an ideal example of the long term civil engineering projects which rarely achieve adequate acknowledgement.

The Hunter Estuary

What Shortland discovered in 1897 was a broad expanse of shoals and mud flats intersected by moving winding channels with water depth of from 2.5 to 4 metres. The entrance beyond the bluff headland of Signal Hill (now Fort Scratchley) was intersected by Nobbys Island. To the immediate north and the south-east of this lay a series of reefs, to the north-west a large unstable sandbank. John Henderson of the Australian Agricultural Company "concluded that the estuary of the Hunter River would not be a suitable harbour for vessels engaged in the export trade".

"Macquarie Pier" - the first harbour works. This breakwater, to close the Southern Channel between Signal Hill and Nobbys was ordered by Governor Lachlan Macquarie in 1818, to be built of stone quarried from the faces of Signal Hill.

This was the first ocean breakwater built in Australia and one of the few major large civil works completed by convict labour.

The Moriaty "Plan" The development of the definitive plan which produced the harbour as we see it today is due primarily to Edward Orpen Moriaty who clearly made use of a plan prepared in 1854 by J. Woolston Ellis C.E. (Moriaty was appointed in 1855 as Engineer for Hunter River improvements).

The basic plan had three components:

* To train the river by building retaining walls from ships ballast "to fill in the indentations in the wharf line (some of these were large lagoons) to bring to one fair sweep".

* To build a northern breakwater extending from inshore of Pirate Point.

* To build a retaining wall ("The Dyke") over a kilometre in length, cutting off about one third of the estuary, along the edge of a mudbank. His major purpose was to train river flow to maintain depth along wharf lines. He envisaged partial filling behind this wall to provide access to additional wharf space along the river bank and also some dredging to produce an inner basin with extra wharf space.

As a recent historian (Bairstow) has commented "The concept was grandiose, possibly the biggest harbour construction proposal in the Southern Hemisphere". At the time the extended wharf space must have seemed absurd. By the 1920's it was all in use.

Prof. Henderson has stated: "The conclusion is that these early works were not only sound enough to form the basis for all subsequent development of the port, calling only for some extensions of some dredging particularly after floods, but no major revisions. They also had that element of novelty and originality which helps to make an engineering work a landmark".

The Development of the Plan.

Representative Government was granted to N.S.W. in 1855. A wide ranging Department of Public Works was then formed. It appointed Edward Moriaty as Chief Engineer for Harbours and River Navigation in 1858 (until his retirement in 1888). All harbour works were the responsibility of that branch of P.W.D. until 1978 when complete control of engineering as well as operation of the Harbour passed to the Maritime Services Board of N.S.W.

The river retaining walls grew steadily at low cost with dumping of ships ballast and fill behind by dredged sand. An even shoreline was established in front of the city and main railway line and around the tip of Stockton by about 1870, the Dyke was completed by dumping on "a line of poles" at the edge of a sandbank by 1874. Backfilling, establishment of rail links and sidings and installation of hydraulic cranes enabled transfer of coal loading from city to the Dyke in 1878. As shipping demand grew, Moriaty's Basin was completed by 1915.

This work continued with the formation of Throsby Basin for the floating dock and heavy duty wharves and reclamation of islands upstream of the dyke to form Walsh Island in 1915. Extensive reclamation straightened the south branch of the river from 1915 onwards forming a site for the steel industry. The program culminated with retaining walls around the remaining islands to form by 1961 the 2500 hectare Kooragang dash industrial land and wetland reserves.

The Breakwaters

Problems abounded with lack of adequate rock material, intermittent funding from the State Government, the unstable "oyster bank" below the Northern Breakwater and the unexpected extent of sand-drift southwards from Stockton Beach. The planned Northern Breakwater was completed by 1886 but could not be stabilized seaward. By 1896 a new Northern breakwater was commenced extending another nine hundred metres. This was completed and stabilized by 1912. Macquarie's "pier" suffered several washaways and was finally stabilized by 1872. The Southern Breakwater was built out to Big Ben reef by 1883 but was not fully stablized until 1950 by which time sixty ton concrete blocks were used.

Deepening the Harbour

Occasional heavy floods deposited huge amounts of silt (20 million tons were estimated for the 1950 and 1955 floods). However, the training walls supplemented by dredging normally maintained a depth of 6.6 m, adequate until about 1900. This limit was imposed by rock falls near Dyke end and near the entrance, extending beyond Nobbys with heavy ocean exposure. Rock breaking by conventional means achieved only 8.4m by 1950. At this time breaking by stages to 10.5m was proposed. By 1961 a depth of 11.6 m was needed. It was achieved with some difficulty by an internationally experienced contractor. By 1977 deepening to 15.2m was approved. This was completed in 1983 by Westham Dredging using specifically designed speed mounted drill rigs.

The Special Character of Newcastle Port

This brief note cannot encompass the problems - engineering, logistical and political which were overcome and the extensive investigations made in developing an almost unnavigable estuary into Australia's largest port. Nor has any account been given to the development of wharves, of navigational aids and of coal loading equipment which kept in line with the best contemporary practice.

In this century, a number of large specialised deepwater ports have been built rapidly using modern materials handling equipment adequately financed. Newcastle became possible as a port with Governor Macquarie's "pier" from 1818. Edwin Moriaty's vision of a great port allowed steady development from 1860 to meet the growing needs of the city and the region, using the technology and materials available at the time. The current appearance is of a large natural harbour. Some strong visual acknowledgement is needed of the one hundred and thirty years of engineering endeavour which went to produce this.

NEWCASTLE HARBOUR

C. SUGGESTED WORDING FOR PLAQUE

The Port of Newcastle is in 1989 a modern deepwater harbour handling a greater tonnage of cargo than any other Australian port. It was developed to this state from a shallow shoaled estuary by over 150 years of continuous engineering works starting with "Macquarie's pier" from 1818, the first ocean breakwater in Australia and one of the few major convict built works then developed consistently to the plan of Edward Orpen Moriaty of the 1850's under the supervision of engineers of the Department of Public Works and since 1958-1971 of the Maritime Services Board with final deepening of the bars to 15.2 metres completed in 1983.

This plaque commemorates the vision and engineering skill of Edward Moriaty and the many dedicated engineers who continued the task of harbour development.

D. BIBLIOGRAPHY

Moriaty, E.O.	"Breakwater at Stockton" report to the Undersecretary reprinted Maitland Mercury, 13-7-1858.
Moriaty, E.O.	"Navigation of the Hunter" - address to the Philosophical Society of N.S.W., reprinted in full Newcastle Chronical 21-8-1861.
Grant, J.L.	"Development of Newcastle Harbour" Northern Institute of Engineers 1914.
Allen, P.M.	"Port Improvements at Newcastle N.S.W." Inst. C.E. London 1924.
McMullen, H.J.	"Port of Newcastle, History and Development" Paper to Sydney Division I.E.Aust. (in P.W.D. records) August 1950.
Ford, A.R.	"Port of Newcastle - Future Development" re I.E.Aust. 6/11/54.
Ford, A.R.	"Siltation and Dredging - Newcastle Harbour" Annual Conference I.E.Aust, Newcastle 1958
Coulin, E.	"Newcastle Harbour, the Formative Years 1844-1862" (M.S. with Author)
Stewart, I.M.	"Taming the River and the Sea" (in Shaping the Hunter - I.E.Aust, Newcastle Division 1983)
Maunsell, M.	"Edward Orpen Moriaty" 9pp, Jan. 1985, P.W.D. Historical Records.
Bairstow, D.	"Hydraulic Power and Coal Loading at Newcastle Harbour" Australian Journal of Industrial Archaeology 4, 1986.
Rich, N.	"Newcastle" A crisp 10pp typescript history of Harbour Development prepared for a proposed I.E.Aust Bicentenary publication - 1976.

ATTACHMENT E.

NEWCASTLE HARBOUR WORKS

1. Dates of Construction of Major Stages

1818-22	Macquarie breakwater Nobby's to mainland. Convict built. Stone quarried Beacon Hill.
1833	Breakwater recommenced.
1836	Stone quarried from Nobby's to resist washaways after Colonel George Barney appointed Colonial Engineer.
1846	Wall completed from Nobby's to Beacon Hill, but storms and waves continued to cause washaways.
1843	Captain Merion Moriarty (Colonial Harbourmaster) visited Newcastle; work commenced on construction of a ballast wharf. This was a small circular wharf built of stone around the end of a sand spit. Ships arriving in the harbour in ballast tipped the load behind large masonry blocks before taking on cargoes of coal, wool or produce.
1853	Stone wharf demolished, masonry used in construction of boat harbour near Market Street.
1850s	Queen's wharf constructed - hardwood deck on copper-sheathed piles; reclamation work for railway line to wharf.
1859	Steam ladder dredge Hunter launched - built at PN Russell's engineering works in Sydney for Newcastle Harbourworks.
1861	Work on 'Moriar .ty plan' commenced with construction of northern breakwater. Plan involved northern breakwater inshore from Pirate Point with extension beyond Stockton Beach, designed to widen entrance by deepening channel north of Beacon Rock and making navigation safer by lessening danger of ships being driven ashore on the Oyster Bank or the sandspit at Pirate Point. Stone pier built near Pirate Point and wall of bluestone ballast (from shipping arriving from Melbourne) was built up to carry the railway track, but the ballast washed away.
1862	Floods and gales caused washaways in southern breakwater and entrance shoaled. Quarry opened at Waratah; sandshore blocks to 30 tons dumped on southern breakwater. Construction of steam cranes.

1863 Second steam dredge, the Vulcan launched to work in Harbour. Ballast tipped on mudflats between Stockton and Bullock Island built up the Dyke and dredged sand pumped behind training wall to complete reclamation.

1860s New wharf decking completed to 1500 ft, from Pilot Station to Watt St., built along the line of the ballast wall from the 1840s "Moriarty' wharf.

1866 Coal loaders constructed. Reconstruction of southern breakwater continued.

1872 Southern breakwater completed. Work ceased on northern breakwater, but repair work on southern breakwater continued to 1895.

1875 Coal loading wharves construction commenced on reclaimed land at Bullock Island - Stockton. Hydraulic crane wharf.

1884 Work resumed on northern breakwater.

1886 Seaward extension of northern breakwater completed. Large sandstone blocks from quarries at Port Waratah and Stockton used. Sandy point north of entrance eroded rapidly after northern breakwater stabilised.

1895 Newcastle Harbour Improvement Act authorised further construction of northern breakwater and of a southern guide wall. Work commenced 1896.

1903 Work suspended for lack of funds - northern breakwater at 1,899 ft southern breakwater at 4,440 ft.

1905 Work resumed.

1916-1919 Retaining walls at Walsh and Moscheto Islands constructed.

1920-1940s [Not covered]

1950-1	Record rainfall and major floods produced heavy silting and more extensive shoaling than at any time since 1922. All available dredges put to work in Newcastle Harbour, including the new drag suction dredge Richard Vowell.
1950-6	Further heavy floods necessitated extensive dredging again.
1951-58	Reclamation of Moscheto and Walsh Is. undertaken, pumping sand and silt from dredging. Bank linking the two islands completed and plans for industrial use of reclaimed land.
1964	First sub-division of industrial land on Islands Reclamation project. 1,200 ft coal loading berths in Carrington Basin commenced for MSB.
1968	Reclaimed land named Kooragang Island.
1969	New grain loading berth completed.
1972	New Dyke Berths completed at a cost of $1.2 M.
1972-1988	[Not covered.]

2. Key Engineering Personnel

Colonel George Barney	Colonial Engineer 1836
Captain Merion Moriaty	Colonial Harbourmaster 1834
Wolstan Ellis	Consultant 1854
Edward Orpen Moriaty	Superintending Engineer, Newcastle 1855-1858 Engineer in Chief, Harbour River, NSW 1859-88
William Anderson	Clerk of Works 1858-1872
Cecil West Darley	Superintending Engineer Newcastle 1867-1872 Resident Engineer, Newcastle 1873-1881 Engineer in Chief, Harbours & Rivers NSW 1889-1901
Thomas William Keele	Assistant to Resident Engineer, Newcastle 1874-75. Responsible for trigonometrical survey of Port of Newcastle
Robert Rowan Purdon Hickson	Assistant Engineer 1881-1888
Percy Allen	Resident Engineer 1908-1912 Later Chief Engineer Harbours & Rivers
E.O.K. Green	Principal Engineer Harbours & Rivers 1946-1957
A. R. Ford	Principal Engineer Harbours & Rivers 1950-1954
W. Dunphy	Senior Supervising, District Engineer then Principal Engineer Operations 1951-1973
A. Brazier	Supervising Engineer, Newcastle 1969-1987
W. J. Kerle	District Engineer, Newcastle 1970-1975
V. C. Lindsay	Supervising Engineer Harbourworks 1960-1983 then District Engineer, Newcastle

For the Maritime Services Board (for Harbour Development).

J. Wallace	Chief Engineer 1961-1983
G. R. Hore	Resident Engineer 1961-1965
G. Turner	Engineer Development & Reclamation 1976-1979
B. Williams	Engineer Development & Reclamation 1976-1979
J. Layzell	Engineer Development & Reclamation 1979-1984
C. Jenkins	Resident Engineer, Harbour Deepening 1972-1982

Acknowledgement must also be made to the engineering staff of the major dredging contractors.

Dillingham Pty.	(1960-1963)
Westham Dredging	(1978-1983)

FIRST BREAKWATER CONSTRUCTION

The 1818-22 convict built breakwater was the first in the Australian colonies.

MORIATY PLAN 1861-1886

The comprehensive design for breakwaters, deepening of shipping channels and reclamation of land for wharves and coal loading facilities was an outstanding engineering concept. Its execution over 25 years substantially achieved the designer's aims.

FIRST TRIGONOMETRICAL SURVEY

Thomas Keele's trigonometrical survey in 1874-75 was the first river entrance survey scientifically undertaken; a survey in 1880 using more advanced equipment confirmed Keele's longitude and corrected his latitude by only 0.5 sec. C. W. Darley described this as "most satisfactory, and a feather in your cap" Keele became Principal Engineer, Harbours and Rivers in 1900.

5. Documentation

Australian Dictionary of Biography.

Colonial Secretary's Returns.

Public Works Department Annual Reports.

Research Notes, M. Maunsell (in Historical Collection, PWD).

J. E. Gallagher, The Outports of New South Wales (PhD thesis, University of Newcastle, 1979).

J. Armstrong (ed.) Shaping the Hunter (Newcastle: IEA (Newcastle Division) 1983).

Ports, June 1983.

AONSW 2/892; 2/895; 2/896.

L. Coltheart & D.I. Fraser, Landmarks in Public Works (Sydney: Hale & Iremonge. 1987).

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16/2/88

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ATTACHMENT F.

NEWCASTLE HARBOUR WORKS AS A NATIONAL ENGINEERING LANDMARK

The purpose of this note is to comment on the early development work on the harbour, particularly the work done in the period 1855 - 1865 by E.O. Moriarty. His report to the N.S.W. Government in April 1858 (1) and his paper read to the Philosophical Society in August 1861 (2) deal at some length with the problems and proposed solutions in the development of Newcastle Harbour. The measures required were: breakwaters to protect the harbour entrance from wave action and from the influx of sand from the coastal beaches; channel regulation works inside the harbour, which is a river estuary, to deepen the navigation channels and improve the outflow of sediment; and to make similar improvements in the river channel up as far as the port of Morpeth.

The breakwaters worked well from the start, although extensions were required in later years. The internal regulation works undertaken by Moriarty from 1858 onwards and earlier proposed by J.W. Ellis (in 1854) consisted of training walls within the harbour (the "Dyke" in particular) and training works plus some channel narrowing in the river upstream. These works had the immediate (and sustained) effect of deeping certain channels, e.g. from nine to eighteen feet within the harbour, and from five to eleven feet in the river between Newcastle and Morpeth.

River and estuary training work of this kind was not unknown at the time elsewhere in the world, but was by no means universally understood and practised, certainly not with the success enjoyed by Mr. Moriarty, whose personal understanding of river mechanics could well be the envy of later generations of engineers.

Furthermore, there was then little available in the way of more general approaches to these problems. The Mississippi River Commission, later well known for river training work, assisted by advanced technology including model studies, was not established until after 1865; in Mark Twain's days as a steamboat pilot before 1861, he had to take the river as he found it. River model studies were unknown until the Frenchman Fargue, in 1875, made his study of Bordeaux harbour in the estuary of the Garonne (3). This model settled an argument between those who thought that dredging alone would keep the harbour clear of sediment and those who thought that regulating works also were necessary. Fargue found in favour of the latter faction; Ellis and Moriarty had done the same about 15 - 20 years earlier without the help of a model study.

The conclusion is that these early works were not only sound enough to form the basis for all subsequent development of the port, calling only for some extensions, and some dredging particularly after floods, but no major revisions; they also had that element of novelty and originality which helps to make an engineering work a landmark.

(1) E.O. Moriarty "Breakwater at Stockton" Report to the N.S.W. Under Secretary for Lands and Public Works, April 4, 1858. Reported in the Maitland "Mercury" July 13, 1858.

(2) E.O. Moriarty "Navigation of the Hunter" Address to the N.S.W. Philosophical Society, August 1861. Reported in the Newcastle "Chronicle" August 21, 1861.

(3) John R. Freeman "Hydraulic Laboratory Practice" A.S.M.E. Publication, 1929.

F.M. Henderson

F.M. Henderson

19 December 1988

G. EXTRACTS FROM A PAPER BY E. O. MORIATY

The harbour of Newcastle, which forms the embouchure of the Hunter River, had formerly two entrances, one on the north, the other on the south side of Nobby Island, the latter channel being that principally used by vessels in former times; but as it was found that the island of Nobby and its outlying reefs did not sufficiently protect the harbour from the in-run of the waves, which during heavy gales, rolled completely into the harbour, rendering it unsafe for vessels to lie in the more open and exposed parts, it was determined by government to close up the south channel by running a breakwater across it, to connect the headland called the Beacon with Nobby. This work was commenced and carried out nearly to completion by prison labour, and its effects in tranquilising the waters of the harbour, have completely realised the anticipations of its projectors.

Nobby Head and the rocky edges at its foot form the eastern side of the entrance; the western side consists of a sandy beach, extending in an unbroken line from Newcastle away to Port Stephens, a distance of nearly 30 miles. This as may readily be supposed, forms a great natural drawback to the entrance to the harbour. The other obstructions o the entrance of the port, which render it in rough weather, almost inaccessible to sailing vessels, and at all times both dangerous and difficult to leave or enter, except with a fair wind and favouring tide, are firstly, the Bar, and secondly, the Oyster Bank, an extensive and shallow sand bank, having only five feet of water on it, which stretches into the very mouth of the harbour. There is a considerable depth of water on the Bar, fully twenty three feet,so that its ill effects are only felt by the rollers or high-rolling waves it creates, and which render vessels at times almost unmanageable when crossing it in rough weather, the peril being increased by its close proximity to the Oyster Bank.

It is apparent that one of the first steps to be taken in order to obviate this evil should be to form the south and east shore of the harbour to a fair gentle curve, by which the course of the ebb tide would be directed seaward avoiding as much as possible everything likely to deflect the stream towards the Oyster Bank. Having brought the south and south east side to a fair curve, the seaward set of the currents, after leaving the harbour, would be insured by the formation of a pier or breakwater, extending from the north sand spit termed the Pirate Point, in a north easterly direction. This latter work would not only make the harbour too open in a direction more favourable for receiving as well as discharging the tidal wave and for concentrating its action on the water bar, but it would alow operate effectually to check the in-run of the sand from the long beach during flood tide. The formation of this pier, has, I am happy to say, been sanctioned by the government and by parliament, and a sum of 5000 pounds having been voted towards it, the work is now about to be commenced.

Within the harbour are extensive banks of pure sea sand, brought in by the flood tide from the long beach, and deposited in the neutral line of the currents; the largest of these is termed the Horse-shore Bank, so called from its peculiar form bearing somewhat of a resemblance to a horse-shoe. Between it and the north shore there is a good deep channel, but the southern edge of the bank comes close down on the southern shore of the harbour, leaving but a narrow channel called the coal channel. This channel was further impeded by bars or shallows, which had formed in places where the irregular line of the shore had favoured the deposition of sand. Since the works have come under my superintendence, I have been gradually bringing the shore line to one uniform curve, filling up the recesses and removing the projecting points The latter has been a most tedious and costly operation for the ballast of which the old wharves had been formed had become thoroughly packed together, so many years have elapsed since it was deposited. The steam dredge is now employed in removing it, which she does at the rate of from 150 to 200 tons of stone per day. I am glad to say, however, that the beneficial effects of bringing the shore to a uniform curve line are, assisted by dredging, now strikingly obvious; for, whereas before the commencement of our operations vessels drawing more than eight feet six inches, or nine feet, could not pass up the coal channel, ships drawing eighteen feet water can now do so.

The works to which I allude, I shall now describe. On the western side of Newcastle Harbour, is an extensive track of sand covered at high water, but left bare as the tide recedes. The flat extends from the northern end of Bullock Island, to a point opposite the Australian Agricultural Company's Wharf. The whole area of this flat, over which the water flows, amounts to about 1600 acres. I propose depositing a corder of ballast along the margin of this bank, the effect of which will be to prevent the water required to cover this extensive area from each tide, flowing as at present over its edge, nearly the whole volume of which will then be diverted into the coal channel. The result will be, a very considerable increase in the quantity of tide water passing up and down the channel every tide, and a proportionate increase in the scouring effect on the sides and bottom of the channel. Ultimately, we shall extend the width of the Dyke, and face it, so as to form a line of wharves, as the trade of the port increases, and the demand for additional wharf accommodation arises.

Hydraulic Power and Coal Loading at Newcastle Harbour, New South Wales

DAMARIS BAIRSTOW

The Hunter River Valley north of Sydney contains one of the richest known and first discovered coalfields in Australia. A series of sandstone escarpments to the south virtually isolated the Hunter from Sydney in the nineteenth century. Exploitation of the Hunter coal reserves necessitated the establishment of a port at Newcastle, at the mouth of the Hunter River. This paper traces the development of Newcastle's coal wharves on what were originally mud flats and sandbanks in the estuary and, simultaneously, the construction of the first of Australia's hydraulic power-houses built to provide power for the cranes. The author is a consultant archaeologist who has worked in Sydney and Newcastle.

The east coast of Australia is not endowed with natural harbours. In the nineteenth and early twentieth century, river estuaries were used for local shipping but, for the main part, the river mouths were shallow. Navigation was hazardous. Furthermore, the eastern rivers are short, being confined to a narrow coastal plain which is cut off from the interior by the Great Dividing Range. Gaps in the Divide are few and far between. Few, therefore, of the river ports had much by way of hinterland to supply or receive trade goods.

One exception to this rule is the Hunter–Goulburn river system, which, alone in New South Wales, penetrates the Eastern Highlands and provides access to the interior. The Hunter Valley contains also one of the richest coalfields in the continent. Coal was a major reason for the establishment, at the mouth of the river, of the first penal settlement on mainland Australia outside the County of Cumberland (Sydney). That settlement was to develop into the city of Newcastle (Fig. 1).

Newcastle, as a harbour, had much the same problems as other river ports. A treacherous sandbank stretched from the north across much of the entrance. Low, sandy islands dotted the estuary. Mudbanks built up near the shores. The harbour as seen today was made not by nature but by man. Indeed, much was the creation of one man, Edward Moriarty.

Early coal loading in Newcastle was concentrated on the south side of the harbour. The south side was protected from prevailing storm winds. The south side was where the mines were. By the 1860s, however, coal exploitation was spreading west as more and more coal companies entered the field. Production increased. Expansion of wharfage on the south side of the harbour was limited by the depth of water. Congestion grew, as did delays in loading.

As early as 1857, Moriarty advocated that wharves be built on Bullock Island, now Carrington, a narrow mudflat partially submerged at high tide, which ran approximately north to south some 3km west of the harbour mouth. The land required would be reclaimed using ships' ballast. In August 1861, Moriarty propounded his views to the Philosophical Society in Sydney. A transcript of his paper was published in the *Newcastle Chronicle* on 21 and 24 August in that year. At that time, a sandbank of some 650ha ran north to south on the east of the island. Moriarty proposed depositing a cordon of ballast along the margin of this bank, which would both prevent it flooding at high tide and also divert the flow to scour a channel east of the ballast. Ultimately, this dyke would be widened and faced with a line of wharves which

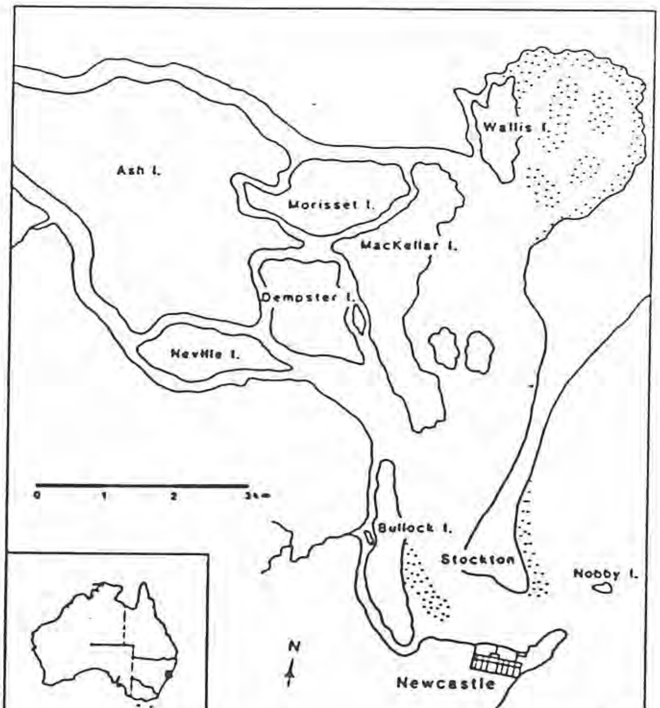


Fig. 1: Hunter River Estuary (c.1824), adapted from Public Records Office (London) Map CO. 201/194.

would be connected with Bullock Island by an area of reclaimed land, leaving some 360ha of water to form an eventual shipping basin to the south.[1]

The concept was grandiose, possibly the biggest harbour construction proposal in the southern hemisphere. It took some time to gain government acceptance and many years were to pass before the project was completed, though it was never intended that the whole be built immediately. From the beginning, however, construction was geared to the eventual creation of the total complex comprising both the dyke and the basin, as dotted lines on harbour charts from this time on indicate. In the maps included here, those lines have been

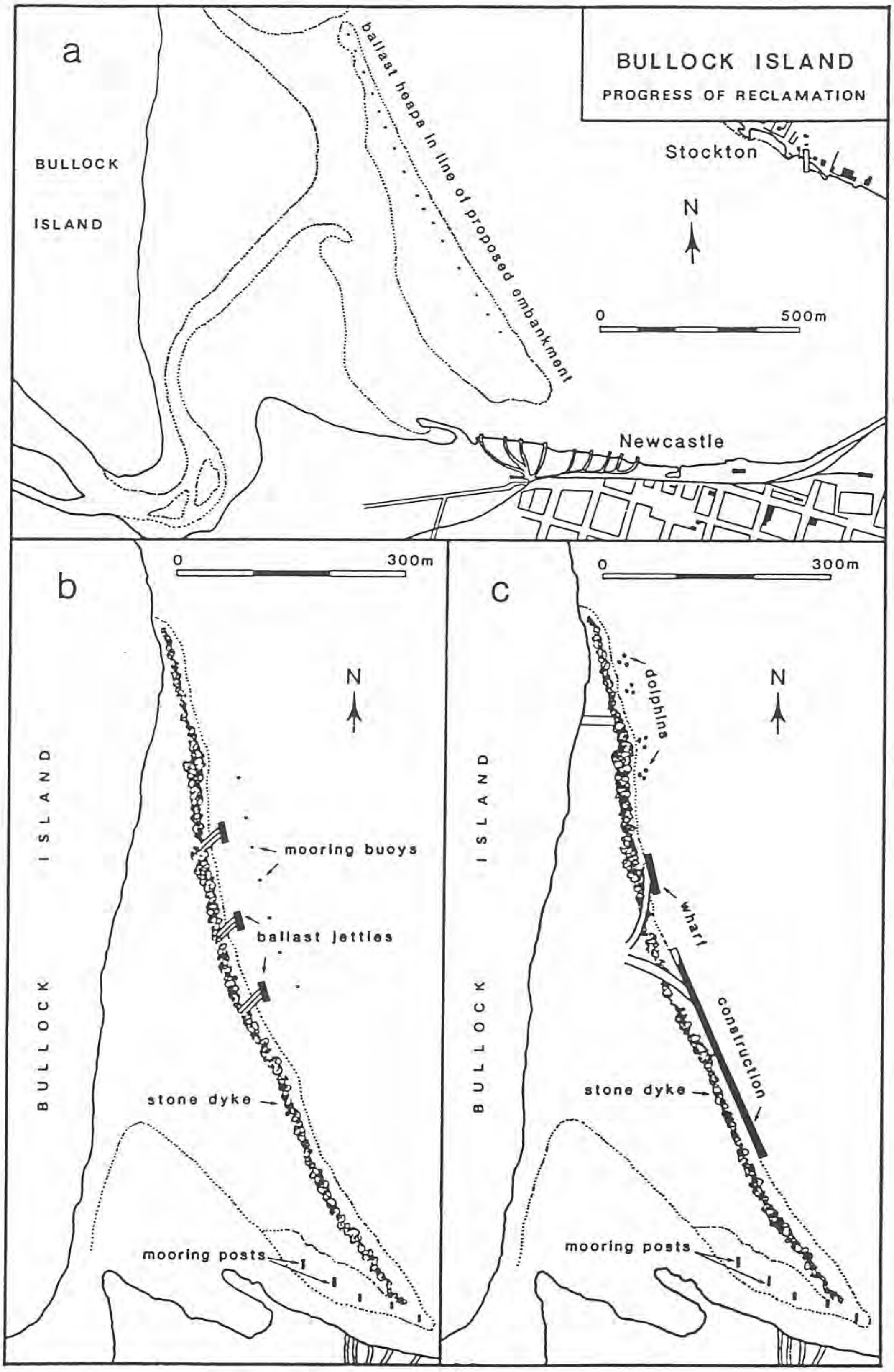


Fig. 2: Reclamation and wharf construction at Bullock Island in (a) 1866, (b) 1874, (c) 1876. Adapted from: (a) J.T. Gowlland: Newcastle Harbour, Newcastle Region Public Library (NRPL) LHM A623.894/28. (b) D.T. Allan: Chart of Newcastle Harbour and Port Waratah, Mitchell Library (ML) M2 811.252/1874/1. (c) D.T.Allan: Chart of Newcastle Harbour and Port Waratah. ML M2 811.252/1875/1.

omitted so that the actual construction over time is made clearer (Fig. 2).

Work began in 1862, if somewhat haphazardly. The *Newcastle Chronicle* in 1863 used the words 'as rapidly as the quantity of ballast arriving . . . will admit'.[2] Gowlland's chart of 1866[3] (Fig. 2a) shows only 'Ballast Heaps in line of Proposed Embankment' but in September of that year a contract was let for the construction of two ballast jetties[4] which, by 1868, were being used to discharge stone. By 1874, the stone dyke

ran the length of the sandbank (Figs 2b & 3) while the channel was being dredged. That year contracts were let for the construction of wharves. 50,000 pounds were voted for a branch railway to connect them to the Great Northern Railway at Hamilton, a distance of about 2km,[5] and the first plans for hydraulic machinery were received from Sir William (later Lord) Armstrong's factory.

Along the Bullock Island Dyke, wharves were built in 30m (100 feet) sections, 60m (200 feet) apart, starting about 230m from the southern end. Seventeen were built in 1875, the same year as the branch railway crossed Throsby's Creek on the west of the island.[6] By 1876, including all sidings, some 11km of single track had been laid, all in steel, designed to last six times as long as the iron rails normally used. In 1876–7, concrete foundations for the first four hydraulic cranes were laid at Berths 4, 5, 6 and 7, 90m (300 feet) apart. In the course of the latter year, the first ten wharves were connected to form a continuous timber-built wharf 838m (2750 feet) long.[7]

Despite the eulogies of the *Newcastle Morning Herald* of Armstrong as a builder of cannon,[8] which is also true, his greater claim to remembrance is as an hydraulic engineer. In 1840 he produced an improved hydraulic engine and in 1845, the hydraulic crane. Soon afterwards he started the Elswick Engine-works, in Newcastle-on-Tyne in England. It was from these works that the New South Wales Government sought to equip the Bullock Island Dyke with the latest in loading equipment, hydraulic cranes powered from a central power-house. The advance of this scheme over anything hitherto known in Australia must be seen in context. Instead of a series of noisy steam cranes, each belching its own smoke and dust, the whole of the motive power was concentrated at one point. Cornish boilers activated, at first, a single 100-horse-power pumping engine which maintained a constant water pressure in vast accumulators, located in towers at each end of the power-house. Each accumulator comprised a vertical cylinder, a massive casting 13.7m (45 feet) high and almost 130mm (5 inches) thick, in which a piston 500mm (20 inches) in diameter with a 7m (23 feet 6 inches) stroke was capped with a weight of 122 tonnes (120 tons). As water was pumped against this weight, the piston rose producing a pressure of 800 pounds per square inch. From here, a series of cast iron pipes 25mm (1 inch) thick carried the water to each crane where it was held in reserve, still under pressure, until needed.[9] The pressure in the pipes was, according to the *Newcastle Morning Herald's* leader of 7 November 1877, 'equal to a column of water of 1,848 feet [563m].' Should the cranes be idle and not take off this pressure, the piston in the accumulator rose to touch a chain which opened a valve in the accumulator itself, letting high pressure water back into the return pipe. Should this fail, a throttle valve cut off the steam to the hydraulic pumps.[10] There was a final safety measure. A slim pipe still runs up the back of the engine-room wall. A further valve allowed steam to pour up this pipe to a steam whistle which shrieked its warning across the Dyke. The drivers could then lower their cranes before the power failed. The cranes they operated were capable of lifting noiselessly 15 tonnes with slow purchase, 10 tonnes quickly, 800 tonnes of coal a day at speeds some 30 per cent faster than steam cranes.[11] To supply water, a 91,000 litre (20,000 gallon) iron tank was built at the Hamilton railway junction, to which water was pumped through sand filters from nearby swamps, four hectares of which were proclaimed for the purpose. Pipes with a diameter of 76mm (3 inches) connected the reservoir to a tank in the power-house engine-room.[12]

The pride in this technology is reflected in the power-house structure. On heavy concrete foundations, then thought essential for any major building on reclaimed land, this Classic Revival edifice is of yellow, compressed brick, with Sydney sandstone quoins, architrave, frieze and pediment (Figs 4 & 5). The roof was boarded and slated. The overall length was 43.9m (144 feet), the depth 26.9m (88 feet). The engine-room measured 21.3 by 12.3m (70 feet by 40 feet 6 inches). The

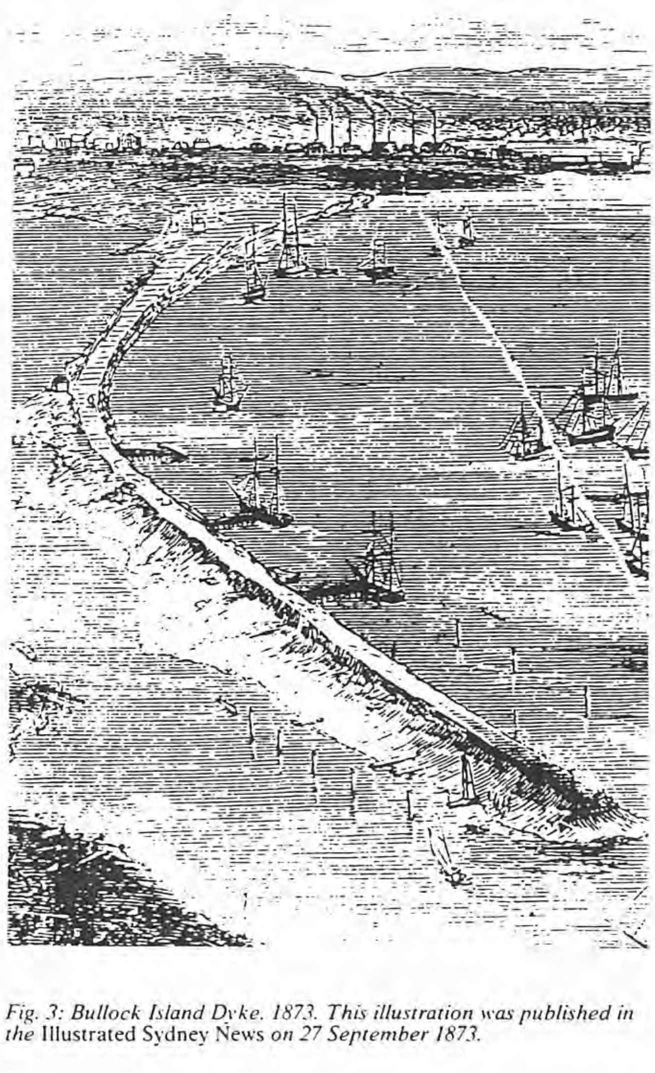


Fig. 3: Bullock Island Dyke, 1873. This illustration was published in the Illustrated Sydney News *on 27 September 1873.*

Newcastle Morning Herald in 1876 gave the dimensions of the boiler-room as 11.9 by 10.2m (39 feet by 33 feet 6 inches)[13] but this seems an error, perhaps typographical. The present dimensions are about 11.9 by 13m (39 by 43 feet) and there is no record nor indication in the building of any extension. The accumulator towers stood 17m (56 feet) high. To the west of the boiler-room was a 22m (72 feet) chimney stack. The *Newcastle Morning Herald* proclaimed:

> 'Where once only the boom of the bittern was heard for ages, the stroke of the busy hammer will resound; and the spot on which the idle aboriginal reclined, as he watched the snipe or red-bill pursue its flight above his head, will be trodden by the restless feet of the white man, or traversed by the Iron Horse.'[14]

Although the power-house was not then completed, the *Town and Country Journal* of 22 July 1876, showed it as it was to be when finished in 1877 (Fig. 4).

In February 1878, Moriarty, by then Engineer-in-Chief, saw the culmination of his plans of twenty years earlier. A crane was tested and 'nearly 18 tons was lifted with apparent ease'.[15] The following month, a locomotive was hoisted from the *Araby Maid* as she lay at No. 6 wharf.[16] On 19 March 1878, the first shipment of coal loaded by hydraulic crane left aboard the *Downiemount* which, on her last voyage to Newcastle, had brought the cranes from Britain.[17] The following year, the *Town and Country Journal* described the cranes as 'the chief glory of Newcastle' and continued:

> 'These beautiful pieces of mechanism . . . represent the last achievments of mechanical science in hydraulic

NEWCASTLE HARBOUR

I. EXTRACT FROM PAPER BY N. RICH

This paper was prepared in 1985 in association with the Maritime Services Board as background material for the then proposed "Engineering Milestones" book.

A full copy of the paper is available at Newcastle Division Office for reference. The extracts highlight some of the major points made in this claim.

"The development of port facilities for Newcastle in the Hunter estuary has been the scene of continuing strenuous effort over more than 150 years. In contrast to Port Jackson, the natural site had very little in its favour for a port. The entrance area, particularly the notorious Oyster Bank, was the graveyard of many ships. Callen listed forty vessels lost on the Oyster Bank in the century from 1805-1905, part of over 100 vessels recorded as lost off the port since Newcastle was first opened up. In fact, the northern breakwater incorporates the hulks of some of the wrecked ships. It was only the economic importance of coal and the profitability of coal cargoes that induced shipowners and masters to risk their vessels thus.

It is probably no coincidence that the two dominating figures in the great expansion of Port Jackson after 1900- the first S.H.T. President, R.R.P. Hickson and the first Engineer-in-Chief, H.D. Walsh - had both been deeply involved in port works at Newcastle prior to their Sydney appointments.

Daring but straightforward in concept, the construction of the breakwaters was to be a continuing battle for the rest of the century. The first stage of the northern breakwater, a key element of the Moriaty Plan, was not stabilised until 1878 but in the meantime (1867) the southern breakwater had blown out. The latter was stabilised by 1872 with sandstone blocks of the then unprecedented size of 30 tons, specially quarried from a site at Waratah.

Meanwhile the world's windjammer fleet was crowding into Newcastle for the precious cargoes of coal. In 1896, coal exports were 2 million tons. At the height of this era, "Newcastle ranked as the world's seventh port, often there were over 100 vessels in port and on one occasion almost as many in port as the rest of Australia put together."

The shape of the modern port had emerged by the turn of the century but three problems were dominating the attention of port engineering staff. These were:

(a) The presence of rock in the entrance channel at about 7.5 metres (24 feet) depth (low tide) for nearly a kilometre, together with rock in inshore areas.
(b) Re-siltation of dredged areas from river floods and sand movement around the end of the northern breakwater.
(c) In rough weather, the "range" of water movement, ie. the surging inside the harbour, was unacceptably large.

The series of hydraulic model studies which commenced in 1950 and were carried out initially at Newcastle University and later at the Manly Vale laboratory for the Public Works Department, in conjunction with the Hydraulic Research Station at Wallingford in England, included research on river silt deposition.

A technical feature of the Islands reclamation work was that the laboratory model tests had shown that reclamation of shallow areas would reduce river siltation inside the harbour channels by reducing or eliminating the "secondary siltation" effect. In fact, maintenance dredging since he lat 1960's has been on a minor scale.

Following extensive office studies and exploratory harbour drilling in the early 1970's, <u>a massive rock removal programme, by far the largest of its type in Australia's history of port development, and one for which there was little precedent anywhere in the world, was undertaken in 1977-83, to provide:</u>

* a minimum depth of 17.7 metres (58 feet) in the approach to the harbour entrance, reducing in stages to -
* a minimum depth of 15.2 metres (50 feet) throughout the entrance channel and the Steelworks Channel, right up to Kooragang Island.
* widening of the channels to permit manoeuvring of vessels up to 290 metres (950 feet) overall length.
* additional deepening throughout the port, to the maximum extent consistent with other navigational constraints and the stability of existing waterfrontage structures.

Technological innovations for this contract included the use of two huge spud-mounted self-elevating drill rigs, built in Newcastle to a Dutch design and use of an early-warning wave-measuring device developed by engineers of the M.S.B., to help ensure safety of these rigs when working in the exposed conditions of the channel approaches. New survey techniques to accurately control the drill hole positions had to be developed. When the contract was completed in February 1983, over 2 million cubic metres of rock (much of it in the difficult outer entrance area) and over 8 million cubic metres of other material had been dredged, using a carefully-staged sequence of drilling, blasting and dredging whilst the traffic of a very busy port continued. The minimum low water channel depth at Newcastle now exceeded that of Port Jackson.

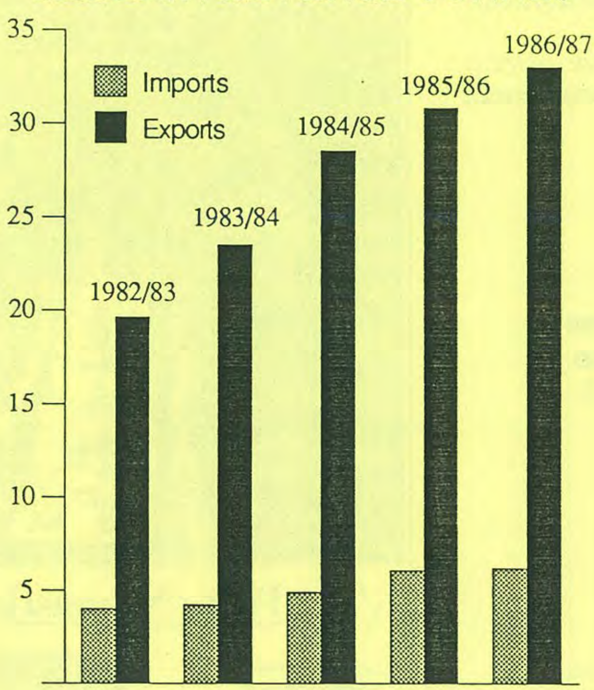
AUSTRALIA'S FIRST COMMERCIAL PORT BECOMES AUSTRALIA'S No. 1 PORT

A little over four years ago Newcastle had a massive queue of ships off the Port (peaking at 54), poor industrial relations, poor reliability in the eyes of customers, and the Port of Newcastle had a less than glamorous reputation overseas. There was only one direction for us to go - and that was up!

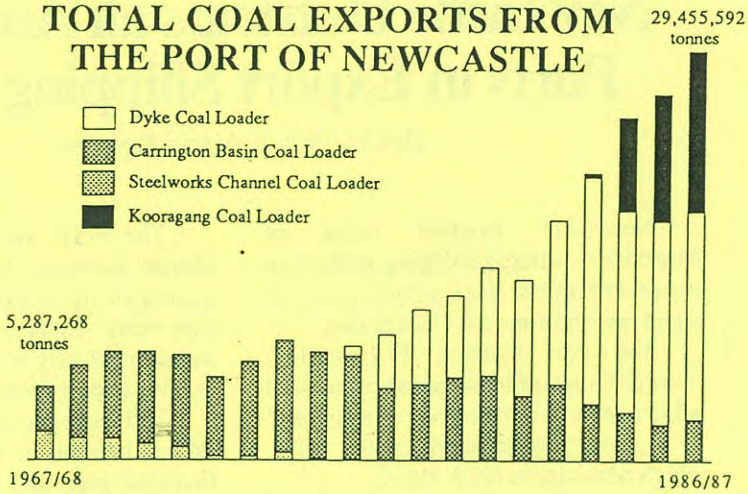
The Port of Newcastle has now achieved the distinction of being the number one Trading Port in Australia. This has been achieved through improved work practices and Port facilities, increased productivity and harmonious industrial relations.

This turnaround has provided the Port with a secure future, and could only have been achieved with consultation, participation, and working together as a dedicated team.

TOTAL TRADE
MILLION REVENUE TONNES



TOTAL COAL EXPORTS FROM
THE PORT OF NEWCASTLE



Developments & Initiatives

Over the last 10 years considerable funds have been invested on Port development works. Some of these include:

* Harbour deepening to 15.2 metres completed in 1981.
* Funding of a seawall at Bicentenary Park, Wharf Road in 1987.
* Purchase of new pilot vessel.
* Provision of state-of-the-art electronic navigation aids.
* Completion and upgrading of No 3 Kooragang berth.
* Upgrading of Signal Station to Port Operations Centre.
* Renovation and upgrade of Pilot Station.
* Provision of a new work boat.
* Swinging basin dredged to enable berthing of the world's largest RO/RO vessel.
* Work injuries were reduced 54% in 1986/87.

A commitment to the future

* Construction of new Mechanical and Electrical Workshops to commence in 1988.
* An additional standby pilot cutter on order.

Australia's No 1 Port will achieve even better results in the future.

Already a development strategy for Newcastle includes work to enable trade through the Port to nearly double to 61.5 million tonnes by 1994/95.

Continued dedicated team work will ensure that Newcastle remains Number 1.

Port of Newcastle

Newcastle Outstrips all Australian Ports in Export Shipping Trade

By Greg Ray, Industrial Reporter

Newcastle handled more of Australia's overseas shipping trade than any other Port last financial year, according to the Maritime Services Board.

The Port handled 39.1 million revenue tonnes of imports and exports, an achievement described as 'outstanding' by a Sydney spokesman for the MSB, which administers NSW Ports.

Exports accounted for 33 million tonnes, including 29.4* million tonnes of coal and 1.6* million tonnes of wheat. Other exports were aluminium and steel.

Imports accounted for 6 million tonnes.

The total volume of throughput put the Port marginally above major single-commodity Ports such as Hay Point, Queensland, and Port Hedland, Western Australia.

Sydney, Melbourne, Brisbane and Fremantle were totally eclipsed. On figures for the June 1987 quarter, Newcastle handled as much overseas cargo as all those Ports put together.

The MSB spokesman said the Port of Newcastle was continuing to improve its performance in the face of difficult trading conditions.

This was due to increased efficiency in the MSB as a whole, and the efforts of the Port's local administration.

Improvements and cost containment had been possible partly because of co-operation by the waterfront unions, he said.

The MSB was delighted that Port charge increases had been held to a quarter of the inflation rate for the past four years. Reduced charges to the coal industry had helped the Port hold its competitive export position.

'All indications so far are that the Port is holding its own in the 1987-88 financial year, and coal exports in particular are expected to strengthen after this current difficult period,' he said.

'In June 1987, 3.3 million tonnes of coal were loaded. This indicates a tremendous theoretical capacity even without additional loading facilities.'

In future the Port of Newcastle would be seeking other opportunities for export of agricultural products, including cotton.

The spokesman said the Port was the MSB's highest revenue earner, though its costs were commensurate with the scale of its operation.

'It certainly makes a major contribution to the Board's revenue,' he said.

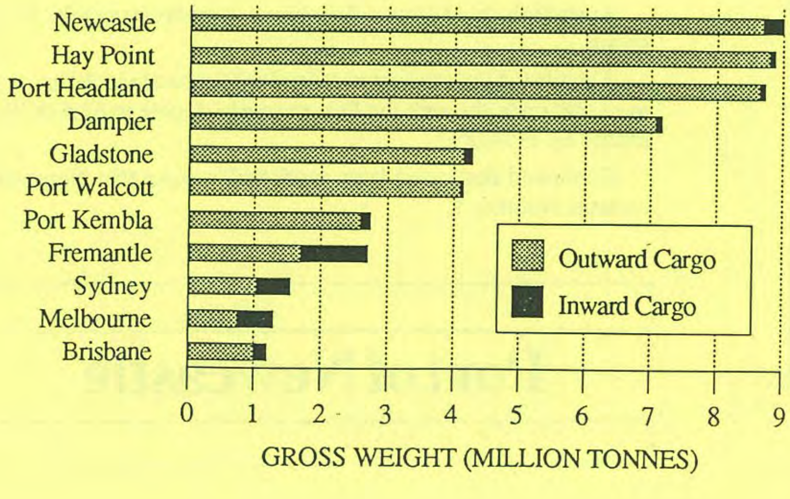
The MSB planned $6.7 million in capital investment at the Port in 1988. The money would be spent on new and upgraded facilities, plant and amenities.

(Source: Newcastle Herald 5/1/88)

** These figures were understated in the original article. The figures included above are correct.*

MAJOR OVERSEAS CARGO HANDLING PORTS

June Quarter 1987



MSB
NEW SOUTH WALES

Port of Newcastle

Tel (049) 27 2400
Telex AA 28761
Fax (049) 26 4596
Telegraph MARBOARD NEWCASTLE

Maritime Services Board
Cnr Scott & Newcomen Sts
PO Box 663
Newcastle 2300

File No.
NM:AN
86/206

1 February 1989

The Institution of Engineers, Australia
Newcastle Division
The Bolton Building
25 Bolton Street
NEWCASTLE NSW 2300

ATTENTION MR IAN STEWART

Dear Mr Stewart

The Port of Newcastle is delighted at your proposal that Newcastle Harbour be recognised as a National Engineering Landmark. I am also pleased to advise that as the "owner" of the Harbour, the Maritime Services Board of NSW is able to support this undertaking.

In response to your enquiry regarding key engineering personnel, the list appears to be correct, however the following minor alterations are necessary:

(1) The Engineer, Development & Reclamation 1976-1979 was 'G' Turner, not 'C' Turner.

(2) The Engineer, Development & Reclamation 1979-1984 was J Layzell, with a 'y' preceding the 'z'.

Copies of the literature requested have been forwarded under separate cover.

Yours faithfully

Geoff Connell
ACTING PORT MANAGER
PORT OF NEWCASTLE

AN022/LANDMARK

PUBLIC WORKS

OUR REF: STE/124

YOUR REF:

Mr J MCC Stewart
Convenor Heritage Subcommittee
Institution of Engineers, Australia
Newcastle Division
P O Box 238C
NEWCASTLE 2300

Dear Mr Stewart

Your letter of 20th January 1987 (8) is acknowledged. The proposal put forward by your Division to recognise Newcastle Harbour as a National Engineering Landmark has the whole-hearted support of the Department.

Mr Will Strachan (Telephone: 02-2317143) from the Department's Coast and Rivers Branch will liaise with you on this project and will provide the information you seek as soon as possible.

With my best wishes for the success of your proposal.

Yours faithfully

M N Clarke
Chief Engineer

IS.

View of HUNTERS RIVER, near NEWCASTLE, New South Wales.

Taken from Prospect Hill.

Dedicated to his Excellency Lachlan Macquarie Esq^r. Governor of New South Wales &c. &c. &c.

Published Nov 10 1812, by A West, Sydney.

[illegible]

No. 6.

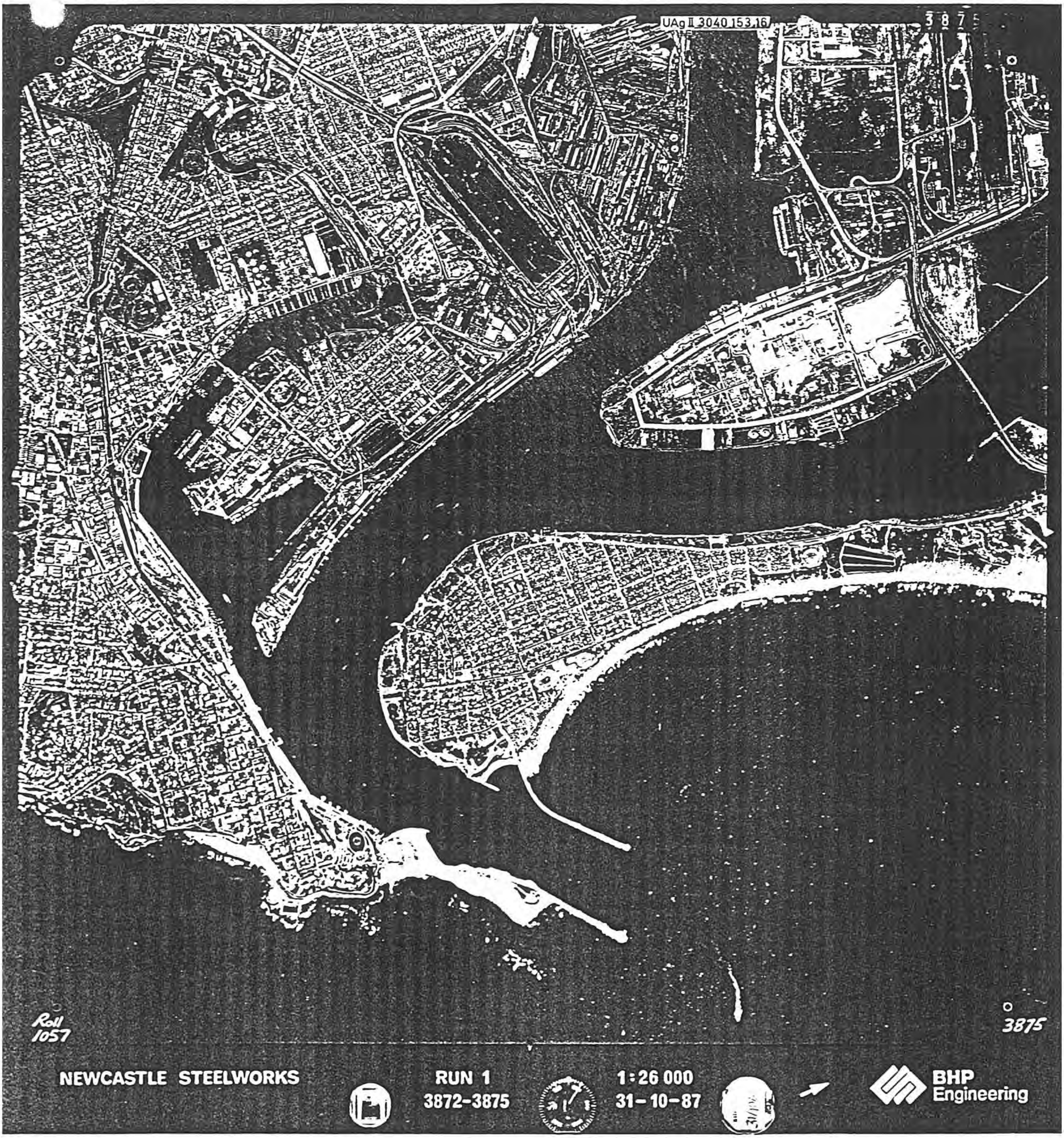
Drawn by J.R. Brown. Engraved by W. Preston

NEWCASTLE, in New South Wales, with a distant View of POINT STEPHEN.

Taken from Prospect Hill.

Dedicated to his Excellency, Lachlan Macquarie, Esq.re Governor of New South Wales, &c. &c. &c.

Published Nov.r 30th 1812, by A. West, Sydney.



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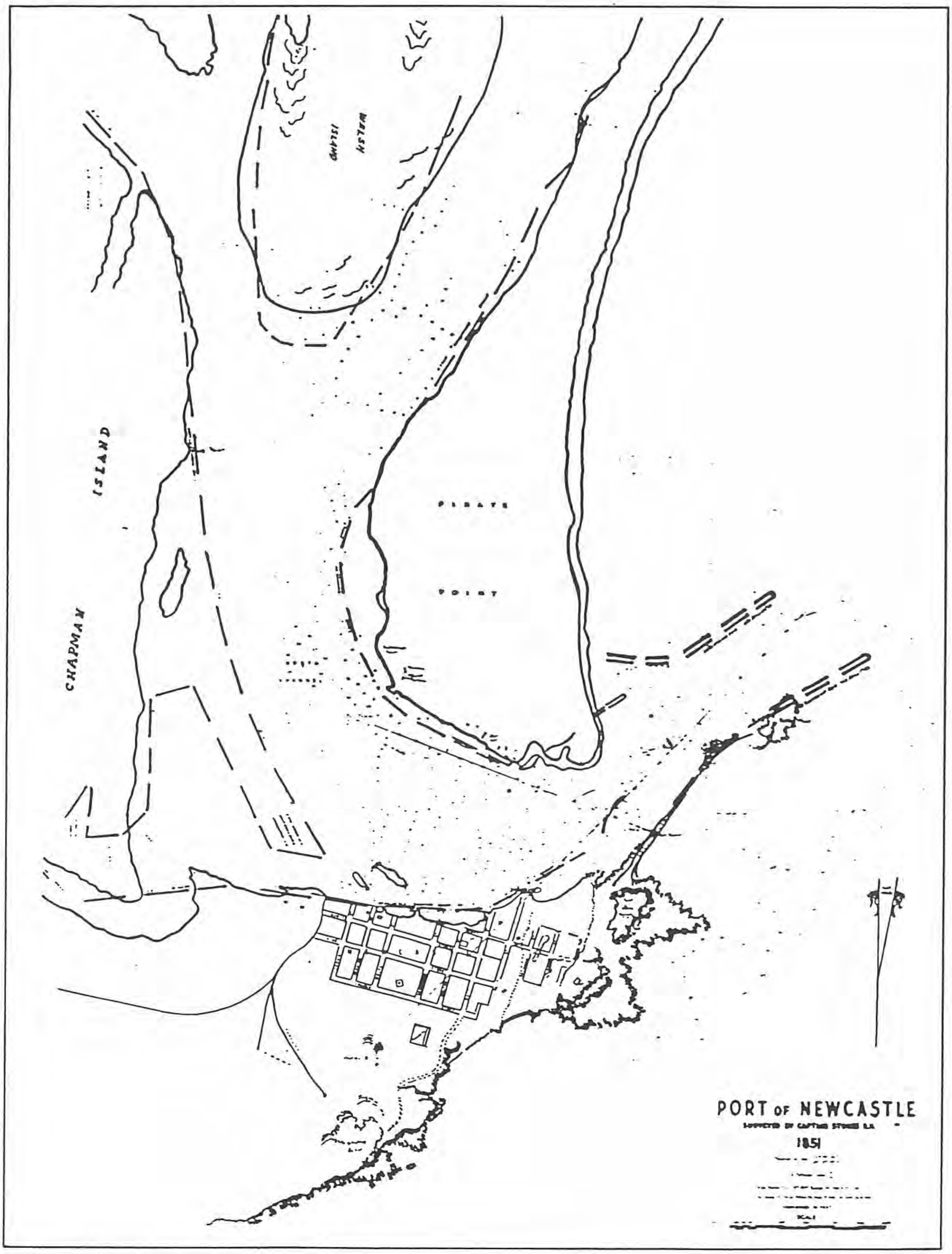
Engineering



The port 1851 and 1950, a composite. *PWD*

The base-plan (full lines) is from Lieut. Stokes' map of 1851. Heavier lines show the highwater shoreline. Broken lines show the 1950 shoreline. By 1982 Throsby Basin, to the west, was completed.